ADVANCED RESEARCH PROJECTS AGENCY

Submission of Proposals

The responsibility for carrying out ARPA's SBIR Program rests with the Office of Administration and Small Business. The ARPA Coordinator for SBIR is Ms. Connie Jacobs. ARPA invites the small business community to send proposals directly to ARPA at the following address:

ARPA/OASB/SBIR
Attention: Ms. Connie Jacobs
3701 North Fairfax Drive
Arlington, VA 22203-1714
(703) 696-2448

The proposals will be processed in the Office of Administration and Small Business and distributed to the appropriate technical office for evaluation and action.

ARPA has identified 20 technical topics, numbered ARPA 94-087 through ARPA 94-106, to which small businesses may respond in the second fiscal year (FY) 94 solicitation (94.2). Please note that these are the only topics for which proposals will be accepted at this time. Proposals can no longer be accepted on those previously advertised 86 technical topics which were numbered ARPA 94-001 through ARPA 94-086. A list of the topics currently eligible for proposal submission is included below, followed by full topic descriptions. The topics originated from ARPA technical offices.

ARPA's charter is to help maintain U.S. technological superiority over, and to prevent technological surprise by, its potential adversaries. Thus, the ARPA goal is to pursue as many highly imaginative and innovative research ideas and concepts with potential military and dual-use applicability as the budget and other factors will allow. In the early years of the SBIR program, most of the promising Phase I proposals could be funded, but as the program's popularity increased, this became more and more expensive. ARPA therefore instituted program changes to fund more Phase Is. These included increasing the number of SBIR topics, and setting more funds aside for Phase I proposals. In order to do this and still have a reasonable amount of funds available for the further development of promising Phase Is, the Phase II awards are limited to $375,000; however, additional funding may be available for optional tasks. Phase I awards are limited to $99,000. Gap funding is not available.

ARPA selects proposals for funding based upon technical merit and the evaluation criteria contained in this solicitation document. As funding is limited, ARPA reserves the right to select and fund only those proposals considered to be superior in overall technical quality and highly relevant to the ARPA mission. As a result, ARPA may fund more than one proposal in a specific topic area if the technical quality of the proposal(s) in question is deemed superior, or it may fund no proposals in a topic area. Each proposal submitted to ARPA must have a topic number and can only respond to one topic.

ARPA has prepared a checklist to assist small business activities in responding to ARPA topics. Please use this checklist prior to mailing or hand-carrying your proposal(s) to ARPA. One additional photocopy of Appendices A & B is requested. Do **not** include the checklist with your proposal.

ARPA 1994 Phase I SBIR
Checklist

1) Proposal Format

    a.   Cover Sheet - Appendix A (identify topic number)   _____

    b.   Project Summary - Appendix B   _____

    c.   Identification and Significance of Problem or Opportunity   _____

    d.   Phase I Technical Objectives   _____

    e.   Phase I Work Plan   _____

    f.   Related Work   _____

    g.   Relationship with Future Research and/or Development   _____

    h.   Potential Post Applications   _____

    i.   Key Personnel   _____

    j.   Facilities/Equipment   _____

    k.   Consultants   _____

    l.   Prior, Current, or Pending Support   _____

    m.   Cost Proposal - Appendix C   _____

    n.   Prior SBIR Awards   _____

2) Bindings

    a.   Staple proposals in upper left-hand corner.   _____

    b.   <u>Do not</u> use a cover.   _____

    c.   <u>Do not</u> use special bindings.   _____

3) Page Limitation

    a.   Total for each proposal is 25 pages inclusive of cost proposal (Appendix C) and resumes.   _____

    b.   Beyond the 25 page limit do not send appendices, attachments and/or additional references.   _____

4) Submission Requirement for Each Proposal

    a.   Original proposal, including signed **RED** Appendices A and B.   _____

    b.   Four photocopies of original proposal, including signed Appendices A and B.   _____

    c.   One additional photocopy of Appendices A and B only.   _____

INDEX OF ARPA FY 94.2 TOPICS

SUBJECT/WORD INDEX TO THE ARPA FY94.2 TOPICS

ARPA 94-087   TITLE: <u>Variable Frequency AC Motor Controller Using MCTs</u>

CATEGORY: 6.2 Exploratory Development; Propulsion and Vehicular Systems

OBJECTIVE: Develop a Four-Quadrant AC Induction Motor Controller Using MOSFET Controlled Thyristors (MCTs)

DESCRIPTION: MOSFET Controlled Thyristors (MCTs) are presently available at ratings of 65 amps and are projected to be available at ratings over 100 amps in the near future. MCTs have the potential to provide higher switching frequencies and higher voltage capabilities than Insulated Gate Bipolar Transistors (IGBTs). Higher operating voltages and higher switching frequencies are necessary to obtain high power density components for the land propulsion systems of future military land vehicles. Pending the availability of MCTs with higher power ratings, the application of the 65 amp MCT is sought in military utility vehicles, such as a battery-powered electric pickup truck. An advanced power controller that uses MCT switches, is sought for the control of a 50 to 100 horsepower AC induction motor. The controller must provide full four-quadrant control. The offeror may use an existing AC motor capable of providing a 4,200 pound truck with a maximum speed of 60 miles per hour and a maximum gradeability of 20 percent.

        Phase I: Design a full control system and test MCT components for a four-quadrant motor controller using the largest MCT rating that is commercially available at the time of design. The motor controller must provide smooth control of vehicle speed and torque under the full range of operating conditions. The controller must operate from a fixed battery voltage (consistent with the selection of a traction motor) and must offer good motor efficiency over the full operating envelope. The final report should include: full design details including schematics, results obtained from MCT laboratory tests, and an integration and test plan for Phase II vehicle testing.

        Phase II: Construct and test the four-quadrant MCT-based controller in a Government furnished electric pickup truck. The Government pickup truck may be assumed to be an S-10 class vehicle equipped with an AC motor and an IGBT-based controller. The Phase II effort should include a complete test plan for the finished vehicle, an evaluation of the efficiency and performance the MCT controller, and a business plan for commercial development of an MCT-based controller.

COMMERCIAL POTENTIAL: Significant commercial potential exists with current and future commercial vehicles.

ARPA 94-088   TITLE: <u>Autonomous Solid-State Position/Attitude Reference Subsystem for Head-Mounted Display System</u>

CATEGORY: 6.2 Exploratory Development; Human-Systems Interfaces

OBJECTIVE: Develop and prototype a self-contained precision reference subsystem (RS) to provide real-time position/attitude data to a visualization system for head-mounted displays.

DESCRIPTION: Meaningful real-time visualization for synthetic environments requires precise knowledge of the viewpoint of the observer. Synthetic environments include simulation used for a vast and disparate array of purposes, such as training of military personnel in combat operations, education of students in historical re-creations, practice of medical techniques, and extrapolation of scientific and numerical analysis into three-dimensional animation. Common among all these applications of simulation is the need to geo-locate the observer's eye-point and field of regard with sufficient accuracy and timeliness to enable the visualization system (whatever it may be, independent of this topic) to generate and display the appropriate viewpoint. The viewpoint must be dynamically updated at a rate that provides no perceptible lag to the observer; i.e., total system (reference and visualization subsystems) updates must be faster than observer perception threshold. Lag is manifested as the tendency for display motion to "fall behind" an observer's head motion, or to even slew in the opposite direction of the observer's rapid head movements. Nominally, the reference subsystem should be capable of continuous complete state vector update at 60 Hertz. It may output the state vector at

lower rates using Distributed Interactive Simulation (DIS) Protocol Data Units (PDUs), and utilize PDU dead-reckoning algorithms to reduce data transmission requirements. The RS state vector should consist of all timing, roll, pitch, yaw, x, y, and z, and all their various acceleration values necessary to detail the dynamic observer viewpoint. The RS must contain all necessary firmware to perform all computations and output. The RS sensors should be independent of and be adaptable for use with a variety of head-mounted display devices. The RS should be autonomous in that it cannot require physical connection to anything off-board the observer; i.e., no trailing power or data cables. The RS could make use of unique mixtures of reference input, such a geo-referenced, augmented differential Global Positioning System (GPS) data, combined with inertial solid-state micro-electronic accelerometers and gravity referenced tilt meters. The system could utilize off-board (off of observer) artificial pseudo-GPS constructs, such as external arrays of pulse-code modulated (PCM) infrared diodes to provide differential location and angular displacement deltas. The absolute location accuracy indicated by the RS in relation to the external world must be self-consistent among all similar devices operating within the same synthetic environment. The relative dynamic accuracy of the state vector output from each RS must be within 0.01% of the depth of the observed synthetic environment in x, y, and z (1 millimeter reference accuracy for a 10 meter deep visual scene), and 0.001 radian in roll, pitch and yaw.

Phase I: Design an autonomous solid-state position/attitude RS for head-mounted display systems; bread-board critical elements thereof to demonstrate feasibility of the approach. Design the software to provide the state vector interchangeable either as DIS PDUs or as engineering data. For the DIS PDU case, provide for the dead-reckoning algorithms on-board the RS, and analyze the changing data output rate requirements for both cases. Explore the use of an "inverted GPS range" using PCM infrared diodes to provide position cues to the RS, and the use of gravity referenced tilt meter and solid-state accelerometers for attitude and motion measurements. Analyze the utility of actual differential GPS as a data source for gross and inter-observer position reference. Design and plan a total system demo to include the pairing with a high-end visualization subsystem and appropriate head-mounted display subsystem, and at least three different types of high-fidelity three-dimensional databases consistent with the simulation topics above. Provide the results of all analyses.

Phase II: Prototype and demonstrate the interoperation of the reference subsystem as designed and planned in Phase I, demonstrating at least two independently operating integrated RS in at least the three databases planned for in Phase I. Provide test results and data to support design decisions and performance. Extrapolate the cost of producing the reference subsystems for mass use. Document the complete interface specifications for generic integration of the RS.

COMMERCIAL POTENTIAL: Successful development of this reference subsystem will enable a new generation of human interaction with synthetic environments, with unbounded commercial potential.

ARPA 94-089   TITLE: <u>Prototype Implementations of Scalable High Performance Computing Software and Environments</u>

CATEGORY: 6.2 Exploratory Development; Software

OBJECTIVE: The design and prototype demonstration of innovative software development tools and environments that will reduce the time and improve the quality of the implementation of high performance computing applications. These tools include, but are not limited to, language preprocessors, compilers, software library managers, code schedulers, code transformers, and debuggers.

DESCRIPTION: This effort encompasses research and development of innovative software development tools specifically supporting the development needs of high performance computing applications. These applications are characterized by a high degree of numerically-intensive computation, extensive use of library software packages, and considerable source and object level code optimization. New approaches for preprocessor, compilers, software library managers, code transformers, and debuggers that can operate in the presence of extensive code optimizations and run-time parallelism are needed. Methods for integrating such tools into a coherent, easy-to-use environment are also highly desirable. Supported source input languages should include those currently popular among the high performance computing applications development community, such as High Performance FORTRAN. Tools to be

developed must be compatible with the operating systems, such as Mach, that are in widespread use within this community.

Phase I: In detail, define the candidate software development tools, system development architecture, technical approaches, interfaces, tradeoffs, and risks in comparison to existing approaches, along with supporting evidence of success, such as early feasibility analyses or prototyping experiments.

Phase II: Prototype, develop, demonstrate, evaluate and deliver software development tools and integrated design environments for high performance computing, along with associated documentation and evidence or performance evaluations that compare results to original predictions.

COMMERCIAL POTENTIAL: Lack of adequate software tools and environments has hampered the rapid development of applications that can fully exploit scalable computing. Innovative products could reduce the time for applications development and improve the quality of implementations. This provides a dual-use opportunity to dramatically improve the development process for computational-intensive DoD applications.

ARPA 94-090   TITLE: Computationally Efficient Parallel Codes, Algorithms, or Tools for Computational Prototyping

CATEGORY: 6.2 Exploratory Development; Design Automation

OBJECTIVE: Create or convert parallel codes, algorithms, or tools enabling the application of scalable parallel computing to various types of design processes.

DESCRIPTION: Research and development leading to design tools that leverage Scalable Parallel Computing technology being developed under the Federal High Performance Computing and Communication (HPCC) Program. Efforts may address any field of design for which significant leverage can be demonstrated; however, the area of electronic systems design, including computing systems and wireless systems, is of particular interest. Efforts of interest include parallel tools that enable or accelerate the prototyping of new processes, devices, modules, or systems. Efforts may either modify existing codes, algorithms, or tools, or create new ones, but in all cases proposals must clearly state what speed-ups are expected for what problem sets and what conditions.

Phase I: In detail, define the application, algorithm, the approach to parallelism, the limits of scalability, and quantify the expected benefits through simulation.

Phase II: Create the full parallel implementation of a tool that embodies the algorithm, and validate the performance on one or more actual design problems running on multiple nodes of an HPC system. Complete documentation of test cases and results must be delivered.

COMMERCIAL POTENTIAL: The development of computationally-efficient parallel design tools will expand the commercial markets for both CAD tools and scalable systems. Dramatic reduction in product time to market enabled by more accurate and rapid design simulation and verification will provide significant advantage to system developers. Scalable computing applied to computational prototyping will also shorten design cycles for dual-use systems by reducing the need for physical prototyping.

ARPA 94-091   TITLE: High Performance Data Compression and Bandwidth Management

CATEGORY: 6.2 Exploratory Development; Communications

OBJECTIVE: Demonstrate high performance compression methods and techniques for efficient use of bandwidth in applications of importance to DoD. High performance here implies achieving high compression ratios while retaining essential features of the data.

DESCRIPTION: DoD has increasing needs for methods which will enable efficient use of bandwidth in a large number of applications. At the same time, several new techniques are emerging, including wavelet-based methods, which offer the potential for efficient compression of data at high compression ratios while retaining essential features

of the data. The goal of this solicitation is to exploit the most recent advances in compression algorithms and to demonstrate methods for efficient use of bandwidth in applications of interest to DoD. Applications of interest range from compression of image and video for transmission to sensor data from military platforms. A key feature of many of these is the requirement to process the data in real time. Solutions may involve algorithmic implementation on commercially available processors, or may involve chip development at later phases.

Phase I: Development and testing (in simulation) of algorithms for compression and bandwidth management. Proposals should include a description of proposed algorithm(s), how it is to be implemented, target application(s), and technical goals (in terms of compression ratios and measures of quality, for example).

Phase II: Enhancement and implementation of the methods in a realistic applications environment including hardware development, if required. A demonstration of real-time application of the techniques in an operational environment should be included.

COMMERCIAL POTENTIAL: General applications in communications, such as providing multimedia communications with substantially reduced bandwidth requirements and efficient transmission and storage of video and audio. There are also many specific applications requiring compression of data, such as acquisition and storage of seismic data for oil exploration. By reducing the amount of data to be transmitted by several orders of magnitude (with substantial loss of performance), one decreases the requirements for bandwidth for transmission and media for storage.

ARPA 94-092   TITLE: <u>Application of High Temperature Superconducting Materials to Composite Structures in Thin-Film Interconnected Electronic Circuits</u>

CATEGORY: 6.2 Exploratory Development; Materials and Processes

OBJECTIVE: Develop procedures for combining HTS thin-film technology with various active and passive components, to achieve greater integration and optimized performance in a single, cooled, package. Near-term applications of high temperature superconducting (HTS) materials will be in electronic modules incorporating integrated circuits (ICs), possibly with other discrete components, such as ferrite circulators and isolators, particularly for military hardware.

DESCRIPTION: In order to enhance the performance of complex circuitry involving ICs, the present trend in electronics integration is to depart from printed circuit boards to multi-chip modules (MCMs), where connections between ICs are much shorter to reduce signal latency. As part of the ARPA program in multi-chip integration, HTS interconnects are used for optimum performance and ease of manufacture, since they require much fewer layers to accomplish interconnections between ICs than do standard metal. Signal shape also is preserved because of the lack of dispersion in these materials. It is of interest to extend the degree of integration to include more than standard ICs (which are in the form of bare die on a substrate), possibly ferrite components and/or other technologies, to achieve as much as possible a complete system function. Since these components also can be derived from patterning films of various materials (including ferrites) on a substrate, a very compact multi-layer package (with multiple substrates) is a possibility.

Phase I: Phase I would require some operational definition of system function, a breakout into different thin-film and component technologies, a description of manufacturability and packaging issues, cooling, and a discussion of system optimization.

Phase II: Construct prototype devices demonstrating high temperature superconducting technology.

COMMERCIAL POTENTIAL: The electronics industry will benefit greatly from this program.

ARPA 94-093   TITLE: <u>Remote, Miniature, Non-invasive Sensors of Body Chemistries and Vital Health Functions</u>

CATEGORY: 6.2 Exploratory Development; Medical Information

OBJECTIVE: There is a need to instantly determine the health status of soldiers or individuals through the use of miniature, non-invasive, unobtrusive (embedded, portable, or wearable) sensors of vital body chemistries (blood, other vital fluids, or tissues) or vital functions (respiration, metabolism, etc.).

DESCRIPTION: Non-invasive sensors of health status are needed in three configurations: 1) wearable, by soldiers, law enforcement officers or individuals while in remote or hostile environments; 2) portable or hand held, by field medics, emergency rescue technicians or nurses to be taken to remote sites or within hospitals and nursing homes; and 3) embedded, within weapons, common appliances (such as toilets or telephones), or other objects, and electronically linked (direct or wireless) to a network. The sensors must be miniature, unencumbering, non-intrusive, robust and require no, or minimal action, from the user. It must have a query mode (the device can be "asked" for a result) and an alert mode (automatically alerts when a value outside of normal parameters is registered). The device must be capable of transmitting the data, either direct or wireless, to a display, portable/hand held computer, or network, data must be usable in a distributive, interactive collaborative information environment to rapidly assess individual health from the point of care or a central site.

       Phase I: Develop a device may be designed to detect electrolytes, blood, metabolites, medications or other chemical parameters in vital fluids such as blood, saliva, urine, feces, expired air or by direct tissue measurement.

       Phase II: Produce a ruggedized, miniaturized remote sensor system for field testing in the battlefield environment, and which has the potential for dual use/commercial applications. If such a potential exists, proposers are encouraged, on an optional basis, to obtain contingent commitment for private follow-on funding to pursue further development of the commercial product after the government funded research and development phases.

COMMERCIAL POTENTIAL: This program would offer profound benefits for Emergency Medical Treatment (EMT) offered by rescue personnel.

ARPA 94-094   TITLE: Test and Applications of Multi-Chip Modules

CATEGORY: 6.3 Advanced Development; Electronic Devices

OBJECTIVE: Develop novel approaches to simplify the test of advanced Multi-Chip Modules (MCM). Develop applications that leverage emerging MCM technologies, enabling new or improved products for computing, telecommunications, automotive, or aerospace applications.

DESCRIPTION: Multi-chip module technology offers the potential to interconnect dozens of "bare" silicon chips in a single package that may be no larger than the conventional package used for a single, complex integrated circuit. At the system level, MCM technology may lead to several potential benefits: 70% reduction in the volume and weight of the electronics, a doubling of the potential performance, and an increase in the reliability by an order of magnitude. While such a technology would have obvious payoffs in a variety of military systems, there is also an enormous potential in volume commercial markets such as computing, telecommunications, automotive, industrial and aerospace. To date, the use of MCM technology for high volume applications has been limited by cost, availability and perceived risks to large vertically integrated companies. The purpose of this topic is to identify new product areas that might benefit from this emerging technology and to explore its application.

       There are at least two types of applications of particular interest: 1) Those where MCM technology can be transparently inserted into an existing system for a savings in size, weight, power or cost; 2) Those where MCM technology enables the creation of completely new or highly optimized products. In some cases, the former may be a precursor to the latter. For example, optimization of a product to take advantage of a 10-100x increase in usable chip I/O, drastic reductions in inter-chip propagation delays, and cleaner signal noise environments might mean repartitioning the functions of various ICs, redesigning off-chip drivers, modifying bus widths and protocols, reducing the supply voltage, and even modifying the system architecture. Examples of newly enabled components include a self-contained wireless local area network (LAN) or high-speed modem module, a high performance processor upgrade, and integrated sensor/control module, or a video processor. Due to their high operating speeds, incorporation of multiple technologies, varying design approaches and lack of accessibility to internal circuit nodes current MCMs are inherently difficult to test. Fundamentally new approaches are needed for both the design of chips and MCMs as well as for the testing of MCMs assembled out of chips obtained from multiple sources. These approaches should be

able to detect defects in the bare die as well as accommodate mixes of circuit type (memory, logic, ASIC, linear) and design-for-test (DFT) strategies within the same MCM. Topics of interest include, but are not limited to, computer-aided test tools, die and substrate DFT tools, test equipment, built-in-self-test, bare die burn-in and test, MCM substrate test, and final module test.

        Phase I: Define detail specifications for the proposed application or approach to test. For all MCM applications, specify the functions of all MCMs and anticipated implementation technologies. Compare the costs and functionality of the MCM-based approach with one based on conventional technologies. Perform a design analysis with detailed trade-off and cost data. Develop a plan to demonstrate the utility of the approach for volume production. For MCM test, develop a plan to demonstrate the utility of the approach in collaboration with an MCM design house, foundry or user. Conduct early proof-of-principle experiments to confirm the proposed approach. Prepare a business plan to ensure commercial availability of tools.

        Phase II: Develop and demonstrate the complete prototype system defined in Phase I for applications, and compare costs, development times and performance with conventional technology implementations.

COMMERCIAL POTENTIAL: Multi-chip modules are a generic dual-use technology required by a broad range of both military and commercial electronic systems. MCMs are an attractive technology solution for nearly all commercial/military products that require high performance and high reliability. MCMs are particularly attractive for the next generations of wireless and hand-held electronic devices. Products (software, equipment, materials, processes) resulting from this effort would be sold/licensed to merchant manufacturers or users of MCMs.

ARPA 94-095   TITLE: <u>Performance of Novel Techniques for Design of Asynchronous, Speed-Independent, Clock-Free Digital Circuits</u>

CATEGORY: 6.2 Exploratory Development; Electronic Devices

OBJECTIVE: Quantify the advantages and disadvantages in speed, complexity, power consumption, and cost of asynchronous logic circuits in comparison to conventional digital logic circuits.

DESCRIPTION: Recently, fundamentally new methodologies for design of Boolean logic circuits have been proposed. Typical configurations substitute signal encoding schemes using two or more conductors per Boolean variable for conventional digital logic, which uses one conductor per variable. The new methodologies can be self-synchronizing, eliminating the requirement for an independent global clock signal as a synchronization mechanism among logic elements. Such self-synchronizing circuits potentially have several properties of interest to DoD. These include elimination of timing-based faults such as races and skew; speed-independent designs (to within device delay limits); greater suitability for high level synthesis; and greater fault tolerance. To date these new design methodologies have been investigated only analytically; no actual devices have been built. Consequently, the claimed advantages have not been tested, and a host of practical fabrication issues have not been addressed. These include design complexity, power consumption, device area, yield, reliability, and cost as compared to conventional circuit designs of similar functionality. This program is directed to the design, fabrication, and detailed evaluation with respect to conventional circuits of sample asynchronous logic circuits.

        Phase I: Select two or more specific, non-trivial digital circuit functions as test cases. Examples include medium scale integration (MSI) components such as multiplexers, and large scale integration (LSI) components such as small microcontrollers. Using standard computer-aided design tools, develop detailed logic, circuit, and physical designs and the simulation results, estimate the area, power consumption, speed, and complexity of the asynchronous, designs and compare to standard commercial designs for the same function. Develop a comprehensive plan for design, fabrication, test, and evaluation of asynchronous digital circuits using standard process and packaging methodologies.

        Phase II: Design and fabricate sample quantities of original two designs, plus one additional design of greater complexity, and compare to standard circuits for realizing the same function in the same process technology.

COMMERCIAL POTENTIAL: Because of their potential to provide a fundamentally new digital circuit technology with improved reliability, reduced complexity, and greater cost effectiveness, asynchronous digital circuits are candidates for inclusion into virtually all commercial electronics, including audio and video equipment, personal computers, telephone equipment, automotive controllers, medical equipment, and so forth.

ARPA 94-096   TITLE: <u>Lock-In Acousto-Optic Time Correlator</u>

CATEGORY: 6.1 Basic Research; Materials and Processes

OBJECTIVE: Design and build an acousto-optic based time signal correlator which can detect, extract, and lock in with a periodic time input signal having an unknown repetition rate.

DESCRIPTION: A lock-in time signal correlator is needed to process time-domain information from a new image-recognition system. The output of the system is a periodic signature signal that is object-specific yet invariant against most of the geometrical transformations of an optical image. While the periodic signature itself is invariant, its repetition rate is a function of the overall scene illumination. The signature amplitude is proportional to the image size, which can be only a few percent of the total scene size. Thus the lock-in time signal correlator must be able to adjust the repetition rate of the reference signature to match that of the input signal, and must be able to extract very low-amplitude signatures from a much stronger total time signal. The frequency range is estimated to be at least 1 MHz, with signature repetition rates from 1 to 100 kHz. The correlator system must include means of storing and adjusting the reference signature, and must be integrated with the overall image-recognition system that produces the invariant signatures.
          Phase I: Perform analysis and design. Simulate the time correlator and determine the region of optimum performance. Fabricate a test bed system and measure its performance to determine its frequency capability and degree of discrimination at low signal amplitudes in clutter. Design a prototype system, fabricate, test, interface with image-recognition system, and evaluate its performance.
          Phase II: Work will depend on the results of Phase I.

COMMERCIAL POTENTIAL: Electronic Industry, Image Processing Industry - This project involves improvements to image recognition processors and developing new and innovative techniques for processing, such that images are object-specific against geometrical transformations. This is needed in rapid identification of objects by automated means without use of prohibitively large memory elements. The image processing industry would develop and sell these units to manufacturing industries for use in automated factories.

ARPA 94-097   TITLE: <u>Personal Computer Based, Tactical Missile Propulsion System, Hardware-in-the-Loop, Thrust Control Simulation/Analysis System</u>

CATEGORY: 6.2 Exploratory Development; Software

OBJECTIVE: Develop a personal computer-based system that can be utilized to simulate and analyze the hardware-in-the-loop response of a thrust control system for a tactical missile propulsion system.

DESCRIPTION: The mission requirements of the next generation of tactical missiles will demand a level of propulsion system flexibility which will dictate the use of non-traditional propulsion systems such as monopropellant rockets, hybrid rockets, bi-propellant rockets, ducted rockets, air turbo ramjets (ATR), ramjets, and turbojets. To achieve the maximum level of flexibility from each of these respective propulsion cycles, a dedicated thrust control system is required. This system will receive throttle commands from the missile mission computer, acquire analog data from propulsion system sensors, and respond accordingly by sending the appropriate signal to the fuel metering device, which, as a result, will modulate the thrust. A means of quickly, economically, safely, but thoroughly evaluating and optimizing propulsion system thrust control is required. A personal computer-based thrust control simulation/analysis system is required that electronically interfaces with the thrust control system and provides a high fidelity, real-time dynamic simulation of the desired propulsion system. The simulation/analysis system must receive commands from the control system, and respond realistically in real-time with the corresponding simulated sensor outputs. The system shall also acquire appropriate control system data and provide an analysis of the control response. The system will be generic in nature, and reprogrammable to simulate a wide variety of engine cycles (including all those mentioned above). The software that is developed will utilize the Windows environment to the maximum extent.

A graphical user interface is essential for rapid reconfiguration, and a library of general engine cycle simulations must be included.

Phase I: Develop and demonstrate a detailed design of the final thrust control simulation/analysis system and a preliminary simulation/analysis system for a single turbojet engine. At the completion of the demonstration, the simulation/analysis system, including all required computer hardware, software (including source code and commercial products), and electronic hardware shall be delivered to the Government for evaluation.

Phase II: Develop a complete thrust control simulation/analysis system including all required computer hardware and software and complete documentation. This system will incorporate an extensive library of engine cycle simulations.

COMMERCIAL POTENTIAL: Civilian Aerospace Industry - The modeling and simulation developed under this effort can be applied to civilian rocket engine development for commercial space applications in support of NASA and civilian independent vehicles.

ARPA 94-098   TITLE: Pulse-Coupled Neural Network for Automatic Target Recognition

CATEGORY: 6.1 Basic Research; Telecommunications

OBJECTIVE: Develop a reliable pulse-coupled neural network which can locate and recognize a given target in a 2 dimensional image plane of approximately 500 x 500 pixels.

DESCRIPTION: Automatic target recognition (ATR) techniques utilizing neural networks have been suggested in literature for many years. One of the theoretically most successful methods is the linking field pulse-coupled neural network model. It should be possible to construct such a neural network utilizing discrete and/or logic components. Such a device could be a major advancement to the ATR problem, both technically and economically.

Phase I: Design and build a prototype neural network capable of locating a target in a 2 dimensional image 256 x 256 pixels on a side supplied to the network via a CPU and a framegrabber. The network can be either optically or electrically addressed or some hybrid of the two.

Phase II: Refine the design to search a larger image plane of approximately 500 x 500 pixels on a side. Also, methods of training the neural network to locate a target while scale and rotation are changing should be demonstrated.

COMMERCIAL POTENTIAL: Manufacturing Industry - The successful development of a neural network processor that can recognize objects, identify them and locate them precisely is applicable to the automated manufacturing industry. This would allow machines to perform inspections of some operations. It could also be useful in surveillance systems for automatic determination of intruder identity (animals or humans, for instance).

ARPA 94-099   TITLE: Advanced Multimedia Imaging Helmets

CATEGORY: 6.2 Exploratory Development; Computers

OBJECTIVE: Develop and demonstrate advanced multimedia imaging helmets for coordination and collaboration of team members in a complex task and hostile environment.

DESCRIPTION: There is a need to design and demonstrate a family of modular, affordable, reconfigurable, and man-portable information-based systems that significantly enhances individual and overall team performance while planning and executing complex high risk tasks. Concepts for one or more variants of a family of advanced multimedia helmets are required. As an example, the range of possible applications include, but is not limited to, development of helmets for mobile shipboard operators (command, fire control, damage control, machinery control, etc.). These individuals must sense, process and display data locally while maintaining connectivity with other remote stations and operators and their distributed sensing, processing and display functionality. Other applications include special forces teams, police/FBI surveillance teams, fire-fighting teams and medical teams. As part of this effort, innovative concepts are sought for sensing, fusing and displaying multispectral imaging data with computer generated #D CAD, text, and

auditory representations in a helmet-based system, while at the same time permitting the operator normal vision and auditory sensing. Characteristics include: Interactive planning and execution software for local expert access, and interactive information exchange for distributed team coordination and remote expert access.

Phase I: Provide a conceptual design for one or more variants of a family of advanced imaging helmets. Demonstrate selected high risk technologies and the extendibility of proposed concepts to related applications. Provide a performance, cost and development risk trade-off analysis with appropriate metrics.

Phase II: Design and demonstrate a full-scale prototype of one or more variants of the proposed family of imaging helmets. Conduct performance and cost sensitivity analysis to demonstrate concept viability.

COMMERCIAL POTENTIAL: This concept is applicable to any team planning or executing complex high risk tasks. Applications include police/FBI surveillance teams, fire-fighting teams, medical and paramedic teams.

ARPA 94-100   TITLE: The Development of a Sonic/Ultrasonic Ocean Spill Clean Up System

CATEGORY: 6.2 Exploratory Development; Materials and Processes

OBJECTIVE: Develop a system capable of separating non-miscible pollutants such as oil from sea water by sonic means.

DESCRIPTION: When two non-miscible liquids such (e.g., oil and water) are simultaneously subjected to ultrasonic radiation, an emulsion or colloid solution is formed. This is a result of the forces at the interface between the two liquids.

Phase I: Develop an initial plan and design of the clean up system concentrating on the laboratory selection of the appropriate frequency and source levels to emulsify oil and water.

Phase II: Design, construct and demonstrate a scaled prototypic ocean clean-up system specifying the application to larger scale clean-ups.

COMMERCIAL POTENTIAL: The potential for commercial use of this technology is extremely high for shipyards, off shore industry, and pollution control activities.

ARPA 94-101   TITLE: Process Technology for Low-Power Electronics

CATEGORY: 6.3 Advanced Development; Materials and Processes

OBJECTIVE: Develop and model aspects of advanced semiconductor process technologies for the fabrication of leading-edge integrated circuits (ICs) that consume markedly lower power than conventional Metal-Oxide-Semiconductor (MOS) technology, without sacrificing data rates or functionality.

DESCRIPTION: Device power dissipation is a significant limitation for a variety of electronic systems. This has been recognized by the semiconductor industry as a "showstopper" to device technology in the late 1990s. This SBIR solicitation will focus on the development of novel models and process technology for low power integrated circuits. Of particular interest for this effort are the following:
(1) Advanced Modeling for Low Power Electronics. This task is focused on development of fundamental device models and circuit level design tools which provide power estimation and optimization. The device models should support fully depleted silicon on insulator structures with threshold voltages below 500 mV and provide an understanding of the device design and process tradeoffs. The circuit models will provide component power estimation and architecture tradeoffs. Each of these models must be computationally efficient and have an integration path to existing design tools.
(2) Shallow Junction Process Technology. This task is focused on the development of low thermal budget processes for shallow junction formation. As the minimum semiconductor feature size decreases, oxide thickness and source/drain junction depth are also reduced. The Semiconductor Industry Association has published roadmaps indicating that source/drain junction depths will decrease from 100nm in 1992, to 40nm by 1998, and to 10nm by 2004.

These requirements will be accelerated for the fully depleted structures of interest. Development of novel approaches to form very shallow junctions is of interest.

Phase I: Perform detailed analysis of proposed approach to create shallow source/drain junctions or model low power electronics. Establish performance and cost metrics, identify major risk factors, develop customer and supplier relationships, and prepare business plan. Perform top-level design. As applicable, demonstrate feasibility of approach through risk reduction experiments or early prototypes.

Phase II: Complete detailed design and implement. As applicable, develop and prototype product in collaboration with suppliers and customers. Demonstrate performance against metrics defined in Phase I.

COMMERCIAL POTENTIAL: These technologies are generic, dual-use, and will be required by a broad range of military and commercial electronic systems. Developed products will be sold/licensed to merchant/captive semiconductor producers for a range of military/commercial applications.

ARPA 94-102   TITLE: Optoelectronic Components for Wavelength Division Multiplexed (WDM) Networks

CATEGORY: 6.3 Advanced Development; Electronic Devices

OBJECTIVE: Develop key optoelectronic components for communication and computer networks exploiting wavelength as a networking strategy. Example component technologies include multiwavelength lasers and laser arrays, wavelength selective filters and switches, and wavelength conversion devices.

DESCRIPTION: Optoelectronic components specifically designed for broadband communication systems are critical enablers for these applications. ARPA-sponsored research on All-Optical Networks has established the advantages of multiwavelength operation as one strategy for increasing network capacity and functionality. Research prototype components supporting this approach to broadband networks have been demonstrated. This solicitation seeks to extend these results to develop and demonstrate manufacturable components that can meet the requirements for deployable multiwavelength networks.

Phase I: Demonstrate prototype manufacturable components for multiwavelength network applications.

Phase II: Develop manufacturing techniques for the prototype components demonstrated in Phase I and demonstrate performance in one of the ARPA-sponsored All-Optical Network testbeds.

COMMERCIAL POTENTIAL: WDM technology is emerging as an effective strategy for broadband communications networks for both military and commercial use operating beyond OC-48, particularly in applications such as survivable SONET rings. Development of manufacturable components specifically designed for these applications should enhance the rate of deployment of these networks and stimulate the development of broadband network applications.

ARPA 94-103   TITLE: Small Lightweight Chemical Species or Warfare Agent Collection Devices

CATEGORY: 6.2 Exploratory Development; Sensors

OBJECTIVE: Collect, detect, and monitor various chemical species for defense and commercial use. The Clean Air Act of 1990 places requirements on industrial facilities to reduce emissions. Municipalities express concern about the quality of the air and water in their localities.

DESCRIPTION: As a consequence of the Gulf War and the threat from unfriendly nations, the use of chemical agents on the battlefield is of continuing concern. Non-proliferation monitoring purposes require the means to monitor the production, testing and deployment of chemical agents. Counter proliferation purposes require the quick collection of chemical agents dispersed from attacks on suspected chemical warfare agent production facilities or chemical agent use by the enemy. Various technologies have been developed to detect and measure chemical agents. A few examples of these are surface acoustic wave devices, gas chromatography, and ion mobility spectrometry. One limiting consideration for use of these technologies is the means by which the chemical species are collected for measurement. Some means require air pumps to move air samples through columns for chemical concentration and subsequent

analysis. Other means include passing air through filters. The species of interest are then removed from the filters by solvent extraction or thermal desorption. Still others use coatings on the sensors themselves as a collector. It takes minutes on site or hours in a laboratory to remove the chemical from the collector. None of these methods include water sampling. Each detection method requires a power source sometimes shared with the collector. This limits the lifetime of a compact device. To advance the capabilities of detection and measurement devices, collectors for air or water sampling should be developed for use in the battlefield, for monitoring outside suspected chemical agent production facilities, and general municipal use. Commercial potential is a consideration in the use of these collectors. The collector assembly should be lightweight (less than 5 pounds), compact (briefcase size and smaller), capable of use in air or water exclusively, use little power (generally less than 5 watts maximum), and have its own compact power supply for greater than 24 hour operation as a standalone system, if needed. Municipal and defense uses would include connection to a 110 volt outlet as an option. Collection time should be short to allow for analysis of chemical warfare agents in less than one minute. Commercial uses would have longer analysis times. The collector should be able to release the collected chemical species to the analysis equipment, as required. Integration into a system using one of the measurement technologies mentioned above or others should be considered.

Phase I: Provide innovative conceptual design of chemical agent collection device. Evaluate size, configuration, environmental effects on collector, selectivity, sensitivity and power requirements. Include technologies such as, but not limited to, gas chromatography, surface acoustic wave (SAW) devices, ion mobility spectrometry and others as analysis equipment for measuring the collected sample. Include possible commercial uses.

Phase II: Design, construct, and test a prototype collection device connected to analysis equipment.

COMMERCIAL POTENTIAL: This program will allow industrial facilities to monitor chemical emissions and adhere to the Clean Air Act.

ARPA 94-104   TITLE: Photonic Radar Systems

CATEGORY: 6.2 Exploratory Development; Sensors

OBJECTIVE: Develop new concepts and approaches in integrated radar system technology utilizing photonic elements to achieve significantly greater system performance.

DESCRIPTION: Photonic technologies have the potential to allow much greater radar system performance that can otherwise be achieved with conventional digital or analog signal processing. As a result, systems architectures which exploit advancements in photonic technology to achieve significant radar performance improvements are being sought. The fully integrated system must be capable of detecting very small radar cross section targets, such as sea skimming and cruise missiles; providing high resolution range measurements; and reducing sensitivity to electronic countermeasures.

Phase I: Address concepts for and approaches to the development of photonic radar systems. Identify the most suitable approach, and perform sufficient analysis and design to indicate a reasonable probability of success in feasibility demonstration.

Phase II: Use the approach defined in Phase I to develop detailed system requirements, build and demonstrate selected critical system elements, and deliver a preliminary radar system technology demonstration design to the Government for evaluation.

COMMERCIAL POTENTIAL: Low cost, low weight radar; ubiquitous radar applications.

ARPA 94-105   TITLE: Improving Manufacturing Quality through the Use of Advanced Vision Techniques for Inspection and/or Mensuration

CATEGORY: 6.2 Exploratory Development; Software

OBJECTIVE: Detect flaws and out-of-tolerance conditions in manufactured objects by use of vision algorithms applied to images of the objects. Images can be obtained from X-ray, tomographic, range-imaging, or electro-optical cameras.

DESCRIPTION: Flaws and out-of-tolerance conditions in manufactured objects can be detected by non contact vision techniques using a variety of sensors. Novel vision techniques are sought that can be implemented in low-cost computers in a factory setting. Such devices should be readily adapted to different objects without requiring skilled programming. Examples of applications include detection of wire bond failures, defects in VLSI wafers and masks, dimensional analysis of cast parts, measurement of surface topography, and 3-D analysis of tomographic data to detect internal flaws in solid objects. (Such flaws can be voids, internal cracks, or non-uniformities that can lead to failure of the object.)
        Phase I: Find a specific manufacturing application and apply the chosen technique to that problem.
        Phase II: Using the application developed in Phase I, indicate the advantages and limitations of the approach and suggest other manufacturing problems to which the approach could be economically applied.

COMMERCIAL POTENTIAL: This effort is directly usable by the commercial world in the area of manufacturing. An inexpensive, reliable inspection/mensuration device will find many applications in flexible manufacturing.

ARPA 94-106   TITLE: Solid Modeling Systems to Support Automated Reasoning

CATEGORY: 6.2 Exploratory Development; Design Automation

OBJECTIVE: Develop, enhance and demonstrate a solid modeling system that will support automated reasoning capabilities.

DESCRIPTION: Current solid modeling systems are basically graphical and geometric representation tools that do not support the capability to reason about the geometry or tolerances or other parameters and features of interest for manufacturing and assembly. This is mainly due to the deficient data structures that are employed in representing information. The ability to reason, both qualitatively and quantitatively, about various attributes of a design is important for developing integrated design manufacturing systems. It is important to be able to represent a design and then easily transition between several different representations. It is also important to be able to develop qualitative and quantitative reasoning algorithms that work directly on the 3D Solid modeler description of a product. Quantitative reasoning, for example, would include, but not be limited to, the ability to determine the degrees-of-freedom of a system of multiple bodies in contact or the ability to reason about tolerancing. Research and development is required that will transition new innovations into the domain of commercial solid modeling systems.
        Phase I: Define and develop several concepts for suitable data structures, evaluate the computational and representational advantages/disadvantages of the proposed data structures, and demonstrate the efficacy of the chosen data structure.
        Phase II: Develop a complete system with an user interface and demonstrate it in the context of an assembly/manufacturing application.

COMMERCIAL POTENTIAL: The technology developed under this research and development effort will be critical for creating the capability to develop real-time executable code, for a flexible assembly cell or a machining workstation, automatically from a 3-D modeler description of the part or the product. This capability, in turn, will form the basis for the future reconfigurable factories and assembly cells that will be able to produce commercial and defense products economically.